Differences in peripheral aberrations in age-balanced hyperopes, emmetropes and myopes

Uchechukwu L. Osuagwu, Marwan Suheimat, David A. Atchison
Institute of Health & Biomedical Innovation, Queensland University of Technology, Brisbane, QLD, Australia

Purpose: Aberrations in the peripheral visual field have been implicated in the development of myopia. Investigators have concentrated on myopes and emmetropes. As significantly higher levels of aberrations have been found on-axis in hyperopes than myopes, this study investigated the differences in peripheral aberrations in hyperopic, emmetropic and myopic groups.
Methods: Cycloplegic peripheral aberration for 5 mm pupils was measured at 39 locations across 42° x 32° of right eye fields with a COAS-HD Hartmann-Shack aberrometer in 9 hyperopes (mean age 29 ± 5 years, spherical equivalent refraction *M* +1.47 ± 0.58 D), 20 emmetropes (28 ± 7 years, +0.06 ± 0.36 D) and 20 myopes (27 ± 6 years, –2.55 ± 1.82 D). Relative peripheral refraction error *RPRE* and 3rd–4th order Zernike coefficients were determined and compared between the groups using repeated measures ANOVAs.
Results: Hyperopes and emmetropes had relative peripheral myopia across the visual field, with considerable nasal-temporal asymmetry for both groups and superior-inferior asymmetry for hyperopes. Myopes had minimal *RPRE* along the horizontal meridian, and less myopic *RPRE* along the vertical meridian than the other groups. There was little difference between groups in astigmatic components or higher-order Zernike coefficients, except for fourth-order spherical aberration C_4^0 which was more positive in hyperopes than in both emmetropes (mean difference ± 95% CI = +0.048 ± 0.046 µm, p 0.030) and myopes (+0.067 ± 0.042 µm, p 0.003). Coma changed rapidly across the visual field with similar rates for all the groups. The rates for C_3^1 along the horizontal meridian (mean rate –0.013 µm/degree), were significantly higher than for C_3^{-1} along the vertical meridian (–0.009 µm/degree).
Conclusions: Hyperopes and emmetropes had greater relative peripheral myopia than the myopes. There were asymmetries in *RPRE* along the vertical meridian for hyperopes which was not present in the emmetropes, suggesting there may be asymmetries in peripheral eye length along the vertical meridian for the former. All higher-order aberrations were affected by field eccentricity, but refractive error affected only the spherical aberration coefficient which was more positive for hyperopes than for other groups. It is unlikely that high levels of aberration contribute to myopia development.
Keywords: Hyperopia, peripheral aberrations, myopia, refraction, higher-order aberrations
Commercial Relationships: Uchechukwu L. Osuagwu, None; **Marwan Suheimat**, None; **David A. Atchison**, None
Support: Australian Research Council DP140101480.

Layman abstract

Investigations into the relationship between peripheral optics of the eye and refractive error have concentrated on myopes and emmetropes due to the high prevalence of these errors. Although significant levels of aberrations have been found in hyperopes than myopes, no study has investigated whether the aberrations differ in the periphery between the groups. This study assessed the differences in peripheral aberrations, by measuring peripheral aberrations at 39 locations across 42°x32° of right eye fields of hyperopes, emmetropes and myopes of similar ages with a COAS-HD Hartmann-Shack aberrometer. Zernike coefficients from the aberrometer were analysed over a 5mm pupil. Peripheral refractive error was more myopic in the periphery than the centre for hyperopes and emmetropes across the visual field. Myopes had more myopia in the periphery than the centre only along the horizontal meridian and less than the other groups. There were significant asymmetries between semi-meridians along the vertical meridian of hyperopes which was absent in emmetropes suggesting possible asymmetries in peripheral eye length along the vertical meridian. All higher-order aberration (3rd and 4th -order coefficients) changed significantly across the field and were not different between the groups except for spherical aberrations which was more positive in the periphery of hyperopes than the other groups. This does not support the role of peripheral aberrations to myopia development.